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Intergalactic Property Law: A New Regime for a New Age

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ABSTRACT

In November 2015, Congress passed the Spurring Private Aerospace Competitiveness and Entrepreneurship Act of 2015 ("the SPACE Act"), which allows private American companies to own any resources they collect from mining in space. This, however, conflicts with current international treaties to which the United States is a party, such as the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space ("the Outer Space Treaty"), which was adopted by the United Nations in 1967. Thus, without some changes, either the SPACE Act will be rendered useless or the United States will be in direct violation of the international laws to which it abides. As a result, this Note suggests that there is a great need to develop a governing body of law for outer space, which will both allow for the development of space mining as an industry and keep the United States within the bounds of its international agreements.

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With movies like *Gravity*, *Interstellar*, and *The Martian* sweeping through Hollywood each year,[1] people are increasingly interested in the future beyond our atmosphere. Notwithstanding these science fiction hits winning awards and attracting attention, real life discoveries are bringing the world beyond the clouds ever closer to home. In July 2015, for example, NASA's New Horizons spacecraft completed its almost decade-long trip to Pluto, providing us with a brand new perspective on the tiny ex-planet.[2] On September 28, 2015, NASA concluded that there is evidence of liquid water (and, thus, the potential for life) on Mars.[3] Demonstrating even more clearly that the future dreamed of in years past is here, astronauts aboard the International Space Station in mid-2015 ate food grown in space, proving that fresh produce can be cultivated beyond gravity's reach.[4]

However, despite these recent discoveries, one of the most important extraterrestrial developments occurred in 2013, when scientists in Scotland discovered several asteroids orbiting Earth close enough to be mined for industrial and precious metals.[5] Unlike many aerospace breakthroughs, which have implications for science and our understanding of the world beyond our atmosphere, this discovery had implications for industry on Earth, as companies poised themselves to retrieve asteroid minerals to compete in what they believe could become a trillion-dollar industry.[6]

The resources available in outer space are incredibly valuable. For instance, mining for lunar water could reduce the costs of

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1. For an undoubtedly incomplete, yet demonstrative list of all the space movies released in 2015, *see* Miriam Kramer, *10 Space Movies to Watch in 2015,* SPACE.COM (Jan. 28 2015), http://www.space.com/28172-space-movies-2015.html [https://perma.cc/44RB-G548].

2. Max Plenke, *The 9 Mindblowing Things NASA Has Already Discovered in 2015*, MIC (Aug. 17, 2015), http://mic.com/articles/123917/biggest-nasa-discoveries-of-2015#.fqqt8tFNd [https://perma.cc/P9B8-N2NU].

3. Gina Anderson, *NASA Confirms Evidence That Liquid Water Flows on Today's Mars*, NASA (Sept. 28, 2015), https://www.nasa.gov/press-release/nasa-confirms-evidence-that-liquid-water-flows-on-today-s-mars [https://perma.cc/N2FF-NVSR].

4. Max Plenke, *Astronauts Are Eating Food Grown in Space for the First Time – Here's Why That's a Huge Deal*, MIC (Aug. 10, 2015), http://mic.com/articles/123635/astronauts-are-eating-food-grown-in-space-for-first-time-here-s-why-that-s-a-huge-deal#.JrAwoJG7v [https://perma.cc/F4XK-RWUX].

5. Keerthi Mohan, *New Class of Easily Retrievable Asteroids That Could Be Captured with Rocket Technology Found*, INT'L BUS. TIMES (Aug. 13, 2013, 5:49 AM), http://www.ibtimes.com/new-class-easily-retrievable-asteroids-could-be-captured-rocket-technology-found-1382529 [https://perma.cc/SZ8Q-XHZQ].

6. *Id.*

colonizing the moon by 90 percent,[7] and extracting asteroid minerals and metals could help man travel well beyond Earth's orbit.[8] On Earth, metals retrieved from outer space could lower costs of chemical elements necessary to produce everything from iPhones to cancer treatments.[9] With these possibilities, commercial companies such as Planetary Resources and Deep Space Industries[10] are taking action to mine asteroids.[11] On September 8, 2016, United Launch Alliance, the space-oriented joint venture between Lockheed Martin and Boeing,[12] launched NASA's OSIRIS-REx spacecraft, which will mine asteroid samples.[13]

But space, though often called the "final frontier,"[14] is not actually a lawless area free for the reaping. It is subject to several national and international laws, most notably the United Nations' Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, now commonly referred to as the Outer Space Treaty of 1967.[15] This treaty holds that "[o]uter space, including the moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies."[16] According to the Outer Space Treaty, everything in space—the moon, Mars, and the several thousand

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7. Sarah Fecht, *Colonizing the Moon May Be 90 Percent Cheaper Than We Thought*, POPULAR SCI. (July 20, 2015), http://www.popsci.com/colonizing-moon-may-be-90-percent-cheaper-we-thought [https://perma.cc/PZ4H-NVS2].

8. Sarah Fecht, *Is Space Mining Legal?*, POPULAR SCI. (Sept. 23, 2015), http://www.popsci.com/it-could-soon-be-legal-to-mine-asteroids?src=SOC&dom=tw [https://perma.cc/JB3H-XQDU].

9. *What Are Rare Earths?*, RARE EARTH TECH. ALLIANCE, http://www.rareearthtechalliance.com/What-are-Rare-Earths [https://perma.cc/28P4-KMTJ] (last visited Mar. 5, 2016).

10. DEEP SPACE INDUSTRIES, http://deepspaceindustries.com [https://perma.cc/6VKX-YCDP] (last visited Feb. 27, 2017); PLANETARY RESOURCES, http://planetaryresources.com [https://perma.cc/9RFP-G8CD] (last visited Feb. 27, 2017).

11. Fecht, *supra* note 8.

12. *Quick Facts*, ULA, http://www.ulalaunch.com/about_quickfacts.aspx [https://perma.cc/XL5P-PX22] (last visited Mar. 6, 2016).

13. *United Launch Alliance Successfully Launches OSIRIS-REx Spacecraft for NASA*, ULA, http://www.ulalaunch.com/ula-successfully-launches-osirisrex.aspx?title=United+Launch+Alliance+Successfully+Launches+OSIRIS-REx+Spacecraft+for+NASA [https://perma.cc/PCF8-WAQH] (last visited Feb. 27, 2017).

14. For the most famous use of the term "final frontier" to describe space, see Vladimir Nunes, *Star Trek - The Original Series - Opening Monologue*, YOUTUBE (Oct. 24, 2015), https://www.youtube.com/watch?v=S6R3MiAv9ac [https://perma.cc/BA5H-G6X3].

15. *See* G.A. Res. 2222 (XXI), The Outer Space Treaty (Dec. 19, 1966).

16. G.A. Res. 2222 (XXI), art. 1, para. 2, The Outer Space Treaty (Dec. 19, 1966).

asteroids (and minerals) within our technological reach—legally belongs to no one.

This is not true for all of space: property rights beyond Earth exist in other instances. For example, all commercial satellites must acquire a "geostationary orbital slot" from the International Telecommunications Union within the United Nations, which affords them property rights to that particular orbit.[17] Asteroid mining, however, is a technological attempt to establish property rights over extraterrestrial resources, rather than available space—running afoul of the international treaties currently governing outer space.[18] Despite this conflict, however, Congress acted to eschew international law on November 25, 2015, when it passed the Spurring Private Aerospace Competitiveness and Entrepreneurship Act of 2015 ("the SPACE Act"), which, among other things, directs the President to "promote the right of US commercial entities to explore outer space and utilize space resources, in accordance with such obligations, free from harmful interference, and to transfer or sell such resources."[19] As a result, any act by an American to exercise his or her rights under the SPACE Act would almost undoubtedly breach decades-old international law.[20]

This Note focuses on that conflict between well-established international treaties and the burgeoning asteroid mining industry, as protected by the SPACE Act. In doing so, this Note suggests that the commercialization of space resources is an important and beneficial industry that should be accepted by international law. But rather than allowing one nation to dictate the rules, or to slowly form property rights on an ad hoc basis, the international community should establish a new space property regime to create a compromise between the established belief that space is "common heritage" and the ability for private businesses to invest and profit from the resources beyond our atmosphere.

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17. JAMES C. MOLTZ, CROWDED ORBITS: CONFLICT AND COOPERATION IN SPACE 112–13 (2014).

18. Brooks Hays, *New U.S. Space Mining Law May Violate International Treaty*, UPI (Nov. 27, 2015, 11:16 AM), http://www.upi.com/Science_News/2015/11/27/New-US-space-mining-law-may-violate-international-treaty/8751448634436/ [https://perma.cc/YKH3-SL5T].

19. Spurring Private Aerospace Competitiveness and Entrepreneurship (SPACE) Act of 2015, 51 U.S.C. §§ 50101–51105 (2012).

20. Katrina Pascual, *U.S. Space Mining Law Is Potentially Dangerous and Illegal: How Asteroid Act May Violate International Treaty*, TECH TIMES (Nov. 28, 2015, 7:25 AM), http://www.techtimes.com/articles/111534/20151128/u-s-space-mining-law-is-potentially-dangerous-and-illegal-how-asteroid-mining-act-may-violate-international-treaty.htm [https://perma.cc/9WMH-HMKP].

Part I will detail the benefits that could flow to both industry and science from private space mining endeavors and will advocate for nurturing the fledgling industry. Part II will survey the international laws governing outer space and show the existing regime that would struggle to accommodate space mining. Part III will outline and compare three potential "futures" for property law over space minerals and will explain the benefits and pitfalls of each option. Finally, Part IV will advocate for a new international regime that creates a governing body of law to oversee the future of the space mining industry.

I. COMMERCIALIZING SPACE RESOURCES AS A BOON TO INDUSTRY AND SCIENCE

It may seem questionable whether an industry with such high initial investment and risk would ever take off.[21] The costs of launching anything into space are enormous: transporting even one kilogram of material to the moon costs roughly $100 thousand.[22] Mining asteroids, however, involves costs exponentially higher than a mission to the moon. Before launching any probes, for example, miners must scan the asteroids with optical and infrared telescopes to decide which asteroids have minerals worth mining.[23] This is not only extremely costly, but also potentially insufficient: because of surface dust and space weathering, the appearance of an asteroid's exterior does not necessarily reflect the mineral bounty within it.[24] As a result, "orbital economics" requires that companies select the asteroids that are easiest and most cost-effective to reach with a spacecraft.[25] Though prospecting companies are in the process of developing more accurate tools,[26] mining companies must select asteroids not based on what the potential gain would be, but based on which are easiest to reach—with little knowledge of whether they are useful or not. Thus,

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21. Adam Brownlee, *The Economics of Mining in Space*, INVESTOPEDIA (Dec. 14, 2015), http://www.investopedia.com/articles/investing/121415/economics-mining-space.asp [https://perma.cc/CH9B-WML3].

22. Amy Coopes, *Space Mining: The Answer to the Rare Earths Problem?*, INDUSTRYWEEK (Feb. 20, 2013), http://www.industryweek.com/transportation/space-mining-answer-rare-earths-problem?page=2 [https://perma.cc/W79C-R39K].

23. Stephen Harris, *Your Questions Answered: Asteroid Mining*, ENGINEER (Apr. 8, 2013), http://www.theengineer.co.uk/issues/april-digital-edition/your-questions-answered-asteroid-mining/ [https://perma.cc/B8F7-N3V3].

24. *Id.*

25. *Id.*

26. *Space-based Observation*, PLANETARY RESOURCES, http://www.planetaryresources.com/technology/#space-based-observation [https://perma.cc/TZ35-TSNM] (last visited Feb. 27, 2017).

companies set themselves up for ventures with enormous costs and potentially very small gains. Despite these costs, though, organizations interested in space mining could recover astronomical benefits, both financial and scientific in nature.[27]

A. Financial Benefits

The primary catalyst for asteroid mining is the potential to reap massive financial rewards. John S. Lewis, chief scientist of space technology company Deep Space Industries, predicted that the value of the minerals in our Solar System is "equivalent to about 100 billion dollars for every person on Earth today."[28] In reality, the profits may exceed that figure by exponential amounts.[29] Massive profits could be brought back to Earth in the form of precious metals, which are tremendously valuable and rare. These metals, called "platinum group metals" (PGMs), have high melting points and are extremely resistant to tarnish and erosion.[30] Known largely for the use of platinum in high-end jewelry, PGMs also play a large role in products like medical tools, computer hard drives, razors, and even fiberglass.[31] PGMs are currently extremely expensive, a result of the fact that these metals only exist on our planet because of meteorite impacts early in Earth's development—meaning they are exceptionally rare.[32] However, PGMs are abundant in near-Earth asteroids. Chris Lewicki, President and CEO of Planetary Resources, Inc., a Seattle-based space technology company, believes "a 500m-diameter asteroid that's platinum-rich actually has as much platinum in it as has been mined in the history of mining."[33] As a result, extracting the PGMs within asteroids could result in enormous payouts for miners. One asteroid

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27. John Aziz, *How Asteroid Mining Could Add Trillions to the World Economy*, WEEK (June 25, 2013), http://theweek.com/articles/462830/how-asteroid-mining-could-add-trillions-world-economy [https://perma.cc/36BS-TR6K].

28. Stephen Dinan, *Congress OKs Space Act, Paves Way for Companies to Own Resources Mined from Asteroids*, WASH. TIMES (Nov. 16, 2015), http://www.washingtontimes.com/news/2015/nov/16/congress-approves-space-act-paves-way-private-comp/?page=all [https://perma.cc/F4DY-UFLH].

29. ASTERANK, http://www.asterank.com/ [https://perma.cc/Q9BE-WZDH] (last visited Feb. 27, 2017).

30. *The Platinum and Paladium Markets*, PLATINUM GRP. METALS, http://www.platinumgroupmetals.net/pgm-markets/default.aspx [https://perma.cc/GY7L-8C8C] (last visited Feb. 27, 2017).

31. *Id.*

32. Stephen Shaw, *Asteroid Mining*, ASTRONOMY SOURCE (Aug. 21, 2012), http://www.astronomysource.com/tag/rare-earth-metals-from-asteroids/ [https://perma.cc/8LQ6-8KSF].

33. Harris, *supra* note 23.

might contain anywhere from $300 billion to more than $5 trillion in PGMs.[34] Thus, the mining of PGMs alone could make it worthwhile for companies to invest in mining asteroids.

Nonetheless, asteroids also house rare earth metals (REMs), a series of elements necessary to produce everything from consumer electronics to cancer treatments.[35] Access to REMs in space could not only increase the supply of REMs on Earth and bring costs of REM products down,[36] but it could also help countries develop REM independence without the environmental dangers typically associated with their mining.[37] Rare earth metals are called "rare" not because they are less abundant, but because they do not appear in concentrated deposits like ordinary metals. Instead, REMs are typically scattered through the crust in less exploitable ways.[38] As a result, the world's supply of REMs comes from only a handful of sources—in the United States, for example, 90 percent of the REMs used for technology manufacturing are imported from China.[39]

Ordinarily, a heavy reliance on imported goods would not necessitate going to outer space.[40] However, the near-monopoly China holds over REMs has led to economic dependence for the United States and other countries.[41] In 2010, China caused international tension when it engaged in an unannounced export embargo of the REMs it produces.[42] Even when not engaged in a full embargo, Chinese control of the resources caused the cost of REMs to rise

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34. Robert Hackett, *Asteroid Passing Close to Earth Could Contain $5.4 Trillion of Precious Metals*, FORTUNE (July 20, 2015), http://fortune.com/2015/07/20/asteroid-precious-metals/ [https://perma.cc/G349-XJPU].

35. *What Are Rare Earths?*, *supra* note 9.

36. Mohan, *supra* note 5.

37. *See* Tony Davis, *Big Pollution Risk Seen in Rare-Earth Mining*, ARIZ. DAILY STAR (Mar. 24, 2013, 12:00 AM), http://tucson.com/business/local/big-pollution-risk-seen-in-rare-earth-mining/article_c604dd80-7a8d-5ab5-8342-0f9b8dbb35fb.html [https://perma.cc/5KJY-WHB2].

38. Gordon B. Haxel et al., *Rare Earth Elements—Critical Resources for High Technology*, U.S. GEOLOGICAL SURV., http://pubs.usgs.gov/fs/2002/fs087-02/fs087-02.pdf [https://perma.cc/TU5Q-UUB5] (last visited Mar. 24, 2017).

39. *Id.*

40. Paul Rincon, *Few Asteroids Are Worth Mining, Suggests Harvard Study*, BBC NEWS (Jan. 13, 2014), http://www.bbc.com/news/science-environment-25716103 [https://perma.cc/7RHX-3AAQ].

41. Mark J. Perry, *Dangerous Dependence: US Increasingly Beholden to Imported Raw Material*, AEI (Apr. 5, 2012), https://www.aei.org/publication/dangerous-dependence-us-increasingly-beholden-to-imported-raw-material/ [https://perma.cc/2FRP-AGBA]; Tekedil Z. Humsa, *Impact of Rare Earth Mining and Processing on Soil and Water Environment at Chavara, Kollam, Kerala: A Case Study*, 11 PROCEDIA EARTH & PLANETARY SCI. 566, 566 (2015).

42. Keith Bradsher, *China Is Said to Resume Shipping Rare Earth Minerals*, N.Y. TIMES (Oct. 28, 2010), http://www.nytimes.com/2010/10/29/business/energy-environment/29rare.html?ref=rare_earths [https://perma.cc/H292-E8YA].

dramatically.[43] Frustrated with the uncertainties of foreign control, many countries around the world—including the United States—have begun to revive their REM processing sites.[44]

Though American REM mining might stop the United States' reliance on China, it has unintended consequences. REM mining comes with serious risks to the environment and human health.[45] Because the concentration of REMs in soil is so low, miners generally extract them with open pit mines, using heavy equipment to create massive holes in the earth.[46] Then, to separate the REMs from the surrounding rock, miners use acid baths and other hydro-metallurgical techniques.[47] These acids, as well as run-off fluids, contaminate the soil and water surrounding the mines, putting human lives and environmental ecosystems at risk of poisoning, disease, and death.[48] Mining for REMs in outer space avoids this problem.[49] And though asteroid mining may not be able to completely supplant traditional REM mining methods for decades, supplementation of mines on earth will reduce pollution and, consequently, reduce health risks.

The benefits of asteroid mining go well beyond industrial benefits on Earth. Mining asteroids and other bodies in space, according to NASA, could further the exploration of our galaxy through "in-situ resource utilization" (ISRU)—using the resources found in space to fuel and resupply missions already beyond Earth's

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43. Andrew W. Eichner, *More Precious Than Gold: Limited Access to Rare Earth Metals and Implications for Clean Energy in the United States*, 2012 U. ILL. J.L. TECH. & POL'Y 257, 267 (2012).

44. Mike Ives, *Boom in Mining Rare Earths Poses Mounting Toxic Risks*, YALE ENV'T 360 (Jan. 28, 2013), http://e360.yale.edu/features/boom_in_mining_rare_earths_poses_mounting_toxic_risks [https://perma.cc/G3QM-YUJH].

45. *See* Humsa, *supra* note 41, at 567.

46. *Environmental Damage,* MIT, http://web.mit.edu/12.000/www/m2016/finalwebsite/problems/environment.html [https://perma.cc/TDM3-43M7] (last visited Feb. 25, 2017).

47. Cécile Bontron, *Rare-Earth Mining in China Comes at a Heavy Cost for Local Villages*, GUARDIAN (Aug. 7, 2012, 8:59 PM), https://www.theguardian.com/environment/2012/aug/07/china-rare-earth-village-pollution [https://perma.cc/T5LL-JRVP].

48. Xiaofei Li et al., *A Human Health Risk Assessment of Rare Earth Elements in Soil and Vegetables from a Mining Area in Fujian Province, Southeast China*, 93 CHEMOSPHERE 1240, 1241 (2013).

49. Leonard David, *Is Mining Rare Minerals on the Moon Vital to National Security?*, SPACE (Oct. 4, 2010, 8:10 AM) (reposted at http://sservi.nasa.gov/articles/is-mining-rare-minerals-on-the-moon-vital-to-national-security/ [https://perma.cc/7BM2-HGWY]) ("Among the policy options flagged in the Congressional Research Service assessment is establishing a government-run economic stockpile and/or private-sector stockpiles. Doing so 'may be a prudent investment,' the study noted, and would contain supplies of specific rare earth elements broadly needed for 'green initiatives' and defense applications.").

atmosphere.[50] Rather than mining for rare or precious metals, ISRU missions mine water to be broken down into hydrogen, which can be used as rocket fuel, and oxygen, which aids in combustion and also provides breathing air for astronauts.[51] Since each pound of propellant, air, food, water, and shelter requires a significant amount of fuel and thrust to be launched into space, using ISRU to make rocket fuel while in space could dramatically increase the potential duration and scope of a mission.[52]

Private companies, such as Planetary Resources, already plan to profit from the creation of outer space re-fueling stations.[53] Rocket fuel in space is worth more pound-for-pound than gold on Earth—satellite operators pay as much as $50 million per ton for enough fuel to maneuver satellites within their geostationary orbits.[54] With over four hundred satellites relying on fuel to keep them within their mandated orbits, there is enormous profit to be made—about $20 billion by Planetary Resources' estimation.[55] Add that to potential fuel sales to NASA and other space missions, and the market for fuel beyond the atmosphere could be worth an estimated $1 trillion.[56] That new market could bring an enormous influx of cash into the global economy and would reduce the amount of space waste, as satellites would not need to be destroyed or taken down when out of fuel.[57]

B. Scientific Benefits

The benefits of asteroid mining are not merely financial, or even restricted to Earth. For NASA and other state actors, whose interests lie more in the pursuit of science than profit, there is still much to gain.[58] Mining technology can be used on other bodies besides asteroids: reports suggest that mining the moon could have nearly

50. *Developing Technologies for Living off the Land.. in Space*, NASA (June 13, 2013), http://www.nasa.gov/exploration/analogs/isru/ [https://perma.cc/5NK8-K29F].

51. Fecht, *supra* note 7.

52. *In-Situ Resource Utilization Mission*, NASA 1, 2 (July 26, 2012), http://www.nasa.gov/pdf/667862main_FS-2012-07-026-JSC-ISRU-Fact-Sheet-Screen.pdf [https://perma.cc/9CYZ-RKY9].

53. *The Trillion Dollar Market: Fuel in Space from Asteroids*, PLANETARY RESOURCES (June 6, 2014), http://www.planetaryresources.com/2014/06/fuelspace/ [https://perma.cc/GG8F-5ABD].

54. *Id.*

55. *Id.*

56. *Market for H2O*, PLANETARY RESOURCES, http://www.planetaryresources.com/asteroids/market-for-h2o/ [https://perma.cc/BDB9-AMN5] (last visited Feb. 25, 2017).

57. *Id.*

58. David, *supra* note 49.

endless benefits for science. Utilization of the moon's natural water and ice, for example, would not only reduce the need for costly and risky resupply missions, but could eventually "help explorers to live on extraterrestrial surfaces."[59] A report from the Lunar Crater Observation and Sensing Satellite suggests that water may be plentiful on the moon and, if it is, the lunar surface could be used for an industrial base that mines water, processes it into fuel, and then sends the hydrogen into orbit to be picked up by spacecraft so that they can travel further into space.[60]

Moreover, mining on the moon could give NASA access to helium-3, an elemental isotope that could potentially be used in place of radioactive uranium to produce nuclear energy.[61] Though some may recall helium-3 as the substance Sam Rockwell's character mined in the movie *Moon*,[62] this element is far from science fiction. It is a molecule that could be combined with a stable isotope of hydrogen through nuclear fission to create energy.[63] Not only does it produce entirely clean energy, but the helium-3 reaction is far superior to traditional nuclear fusion technology in that it does not produce any radioactive byproduct.[64] Instead, helium-3 reactions create regular helium (which is rapidly becoming scarce on Earth) and a stray proton, which can itself be used to create clean energy.[65] As a result, this process has the potential to provide a practical solution to Earth's energy problems.[66]

While evidence shows that this beneficial process could likely function successfully on Earth—a similar process was successfully tested at the University of Wisconsin-Madison[67]—there is insufficient helium-3 on Earth to fuel the process. Earth has very little helium-3 because its magnetic field pushes the molecules away and back into

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59. *In-Situ Resource Utilization Mission*, *supra* note 52, at 2.

60. Fecht, *supra* note 7.

61. Jeremy L. Zell, *Putting a Mine on the Moon: Creating an International Authority to Regulate Mining Rights in Outer Space*, 15 MINN. J. INT'L L. 489, 505–06 (2006).

62. This Author highly recommends this movie, as does Rotten Tomatoes, which rates it 89 percent on the "freshness" scale. *See Moon (2009)*, ROTTEN TOMATOES, https://www.rottentomatoes.com/m/10009075_moon [https://perma.cc/2C44-PW55] (last visited Feb. 25, 2017).

63. Keith Veronese, *Could Helium-3 Really Solve Earth's Energy Problems?*, IO9 (May 11, 2012, 5:40 PM), http://io9.gizmodo.com/5908499/could-helium-3-really-solve-earths-energy-problems [https://perma.cc/5AQ7-W3SW].

64. *Id.*

65. *Id.*

66. *Id.*

67. *Id. See generally* Matt Treske, *Scientists Explore the Use of Helium-3 Collected from the Moon as a Source for a Global Energy Supply*, 116 WIS. ENG'R 1 (Nov. 2011), http://fti.neep.wisc.edu/gallery/pdf/wisengr1111.pdf [https://perma.cc/249N-F88A].

space.[68] The same is not true, however, for the moon, which has an extremely weak magnetic field.[69] A group of scientists at the National Institute for Fusion Science in Nagoya, Japan, believe that the lunar surface contains about ten million tons of minable helium-3, which could provide energy for all of Earth for 500 years.[70]

Although the idea may sound like the stuff of Hollywood films, utilization of lunar resources would not only reduce the cost of sending people to the moon by 90 percent, but could also reduce costs of a mission to Mars by $10 billion per year.[71] With figures like that, it is no surprise that NASA has made ISRU (and the potential use of space mining) a "necessary element" in its plans for future exploration.[72]

For these reasons, several private companies, alongside NASA, are poised to mine for extraterrestrial minerals within the calendar year.[73] Planetary Resources has already launched one low-Earth-orbit satellite to test asteroid "prospecting" technology, and it has plans to launch a second one sometime in 2017.[74] These satellites, named Arkyd, are beta tests of the type of technology companies like Planetary Resources hope to use in evaluating the composition of deep-space asteroids.[75]

NASA, too, launched a probe on September 8, 2016, but instead of testing technology, it aims to acquire and return samples of asteroid minerals.[76] The project, called the Origins-Spectral Interpretation-Resource Identification-Security-Regolith Explorer (OSIRIS-REx), will be the first US mission of its kind, as it travels

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68. Veronese, *supra* note 63.

69. *Id.*

70. Yukihiro Tomita et al., *Use of Polarized Helium-3 for the Energy Production*, 402 NUCLEAR INSTRUMENTS & METHODS PHYSICS RES. SEC. A 421, 424 (1998).

71. Fecht, *supra* note 7.

72. *In-Situ Resource Utilization Mission*, *supra* note 52, at 2.

73. Fecht, *supra* note 8.

74. *Asteroid,* PLANETARY RESOURCES, http://www.planetaryresources.com/asteroids/#asteroids-property-rights [https://perma.cc/C9F6-X24D] (last visited Feb. 25, 2017); Alan Boyle, *Planetary Resources Strikes $28 Million Pact with Luxembourg for Asteroid Mining,* GEEKWIRE (Nov. 3, 2016, 9:26 AM), http://www.geekwire.com/2016/planetary-resources-28-million-luxembourg-asteroid/ [https://perma.cc/U49G-FTA2] (suggesting that Arkyd 6 will be launched in 2017).

74. *Planetary Resources' First Spacecraft Successfully Deployed, Testing Asteroid Prospecting Technology in Orbit,* PLANETARY RESOURCES (July 16, 2015), http://www.planetaryresources.com/2015/07/planetary-resources-first-spacecraft-deployed/ [https://perma.cc/8SY2-4RR4].

76. *Missions: OSIRIS-REx,* NASA, http://science.nasa.gov/missions/osiris-rex/ [https://perma.cc/K7CQ-Q8Z5] (last visited Feb. 25, 2017).

three years to map an asteroid's surface and carry samples from the asteroid back to Earth.[77]

Thus, it is evident that space mining is going to be a lucrative industry in the future, regardless of whether the legal system is ready for it. Now that the US government has embraced space mining through its enactment of the SPACE Act, the growth of privately and publicly funded efforts at space mining will likely proceed—even if the practice conflicts with international law.

II. A HISTORY OF SPACE LAW: THE OUTER SPACE TREATY AND BEYOND

No discussion of space property law can begin without discussing Western law's first conception of owning the sky, which came in the form of the *ad coelum* rule. This rule, which was developed by Romans and adopted into English law in 1273, is short for the phrase "*cujus est solum, ejus est usque ad coelum et ad infernos,*" or "whoever owns the soil owns also to the sky and to the depths."[78] Thus, the ancient law established that the owner of land also owned all land beneath it and all sky above it.[79] However, as the age of flight dawned, it became clear that allowing each landowner rights to the space above his or her land would stifle the air transport industry.[80] That tension eventually led the US Supreme Court to assert, effectively, that the airspace in which airplanes travel is a "public navigable airspace" over which the federal government can assert control.[81]

But the United States, as well as the rest of the world, did not consider the implications for property law beyond the atmosphere until October 4, 1957, when the Soviet Union launched Sputnik I.[82] Although that launch set off an explosion of political issues, it also served as the catalyst for a new area of law: that of the world beyond our planet. Before Sputnik, outer space's legal status was merely theoretical, with common wisdom dictating that typical airspace rules would carry over beyond the atmosphere.[83] However, were that true,

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77. *Id.*

78. THOMAS W. MERRILL & HENRY SMITH, PROPERTY: PRINCIPLES AND POLICIES 10–13 (Foundation Press 2d ed. 2012).

79. *Id.* at 13.

80. *Id.* at 10–13 (citing Hinman v. Pac. Air Transp., 84 F.2d 755 (9th Cir.1936)).

81. *Id.* at 15 (citing United States v. Causby, 328 U.S. 256 (1946)).

82. Matthew J. Kleiman, *Space Law 101: An Introduction to Space Law*, A.B.A., http://www.americanbar.org/groups/young_lawyers/publications/the_101_201_practice_series/space_law_101_an_introduction_to_space_law.html [https://perma.cc/JUR2-2B3S] (last visited Feb. 25, 2017).

83. *Id.*

then Sputnik's launch—the trajectory of which went through many countries' airspace—would have breached international law stating that each country owned the airspace immediately above it.[84] As a result, any country (including the United States) could have legally shot the little satellite out of the air.[85] However, President Eisenhower and his administration wanted to develop similar satellites to spy on the USSR, so it "tacitly accepted" Sputnik's launch, establishing by assumption that space law would be governed in a manner wholly different from airspace law.[86]

Historians can only theorize about what made the world's two superpowers refrain from a military arms race and instead begin what was effectively a technology race.[87] In the end, however, the two nations selected a more peaceful resolution than could have been predicted, and a presumptive ban on deploying weapons of mass destruction into space was quickly adopted by the United Nations on October 17, 1963.[88] This acknowledgment of the need for international space law was exceptionally fast, especially considering that the first international treaty governing airspace was not created until sixteen years after the Wright brothers' first engine-powered flight in 1903.[89] Historians credit this speed to the fear surrounding the ability to conquer the space beyond Earth.[90]

As a result, the international community worked to create a formational document for the realm of space law. Less than ten years after the launch of Sputnik, the United Nations General Assembly completed a broad agreement adopting principles for the peaceful exploration and use of outer space in December 1963.[91] This resolution was adopted as international law only a few years later as the Outer Space Treaty in January 1967.[92]

The governing philosophies adopted by the Outer Space Treaty, which are still in effect today, posit themes of peace and common

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84. *Id.*

85. *Id.*

86. *Id.*

87. PETER JANKOWITSCH, HANDBOOK OF SPACE LAW 1, 3 (Franz von der Dunk ed., 2015).

88. *Id.*

89. *See Wright Brothers Test Flight, 1909*, HIST. CHANNEL, http://www.history.com/topics/inventions/wright-brothers/videos/wright-brothers-test-flight-1909 [https://perma.cc/6944-FKBF] (last visited Mar. 6, 2016).

90. JANKOWITSCH, *supra* note 87, at 4–5.

91. *Id.* at 4.

92. *Id.*

ownership.[93] Most notably, the Outer Space Treaty mandates that outer space exploration and use of extraterrestrial resources be exclusively for "the benefit and in the interests of all mankind," that outer space and the celestial bodies are not available for national appropriation, and that states shall be responsible for their activities in outer space, whether carried on by the government itself or by non-governmental entities (such as corporations).[94] These principles departed substantially from the typical approach to international law, which allowed for military dominance, war, and national ownership.[95]

This peaceful and collaborative ideology set forth by the Outer Space Treaty was the governing foundation for the treaties that followed.[96] In the twelve years following its enactment, four notable space treaties expanded upon the Outer Space Treaty's principles.[97] The first, the Agreement on the Rescue of Astronauts, the Return of Astronauts and Return of Objects Launched into Outer Space ("the Rescue Agreement") provided that "States shall take all possible steps to rescue and assist astronauts in distress and promptly return them to the launching State, and that States shall, upon request, provide assistance to launching States in recovering space objects that return to Earth outside the territory of the Launching State."[98] Noting that it was specifically designed "to give further concrete expression to the rights and obligations contained" within the Outer Space Treaty, the Rescue Agreement created a feasible instance in which the global community would be required, by law, to act together.[99]

Four years later, the United Nations passed the Convention on International Liability for Damage Caused by Space Objects ("the Liability Convention"), which is considered one of the most interesting

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93. Amy S. Teitel, *The Outer Space Treaty Promised Peace in Space,* DISCOVERY CHANNEL (Oct. 10, 2013, 12:52 PM), http://news.discovery.com/space/history-of-space/the-outer-space-treaty-promised-peaceful-exploration-of-space-131010.htm [https://perma.cc/5Q7E-J5W5] ("But the 1967 Outer Space Treaty has kept any military activity in space from developing into a full-blown face-off. And it still stands as the governing document of space programs, one that all spacefaring nations have agreed to.").

94. Kleiman, *supra* note 82.

95. JANKOWITSCH, *supra* note 87, at 5.

96. *Id.*

97. *Id.* at 6.

98. *Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space,* U.N., http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introrescueagreement.html [https://perma.cc/5S5P-4JDS] (last visited Mar. 6, 2016); *see* G.A. Res. 2345 (XXII), at 5 (Dec. 19, 1967).

99. G.A. Res. 2345 (XXII), at 6; JANKOWITSCH, *supra* note 87, at 6 (noting that the Rescue Agreement was passed following the tragic deaths of the Apollo 1 crew, Roger Chaffee, Ed White, and Gus Grissom, who were killed by a fire in their space capsule).

international legal instruments of its time.[100] This agreement, which took nine years to negotiate, held that launching states would be held absolutely liable for all damage caused by their space objects—a term of art still debated to this day[101]—to other aircraft or the Earth itself, while holding them liable for damages caused in space as well.[102]

The third agreement to stem from the Outer Space Treaty was the Convention on Registration of Objects Launched into Outer Space ("the Registration Convention"), which provided for a registry for all items launched by state parties, so that each member state could be aware of actions taken in space.[103] By creating the Register of Objects Launched into Outer Space,[104] this agreement allowed all nations to keep track of what was going in and out of the common heritage space and provided for ease in mandating payments if any damage occurred.[105]

Despite the importance of those three agreements, however, the most notable application of the Outer Space Treaty's ideology was the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies ("the Moon Treaty"), which labeled the Moon and its natural resources the "common heritage of mankind."[106] When adopted by the General Assembly in 1979, it reaffirmed the main tenets of the Outer Space Treaty while providing that "the moon and other celestial bodies should be used exclusively for peaceful purposes, that their environments should not be disrupted, [and] that the United Nations should be informed of the location and purpose of any station established on those bodies."[107] But the treaty was groundbreaking in its adoption of a "common heritage" approach to extraterrestrial resources, which promoted an international regime to "govern the exploitation of such resources when such exploitation is about to become feasible" as the crux of its mandate.[108]

The "common heritage" approach to international property relies upon five core beliefs: (a) there is no private or public

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100. JANKOWITSCH, *supra* note 87, at 7.

101. Olavo de O. Bittencourt Neto, *The Elusive Frontier: Revisiting the Delimitation of Outer Space*, IISLWEB, http://www.iislweb.org/docs/Diederiks2013.pdf [https://perma.cc/62KQ-WUTK] (last visited Mar. 6, 2017).

102. *Convention on International Liability for Damage Caused by Space Objects*, U.N. http://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/introliability-convention.html [https://perma.cc/H3JY-VWLC] (last visited Mar. 6, 2017).

103. *Id.*

104. G.A. Res. 1721 (XVI), at 6 (Dec. 20, 1961).

105. *See* G.A. Res. 3235 (XXIX), at 16 (Nov. 12, 1974).

106. G.A. Res. 34/68 (Dec. 5, 1979); JANKOWITSCH, *supra* note 87, at 5.

107. G.A. Res. 34/68.

108. *Id.*

appropriation of property or land within the common heritage; (b) all states must take care to manage the resources and environment within the common heritage for the benefit of all other states; (c) states must share the benefits and gains acquired from exploiting the area within the common heritage; (d) no weapons or other military installations may be built or placed within the heritage territory; and (e) the states must preserve and protect the space for the benefit of future generations.[109] The common heritage concept has already proven successful when applied to the Earth's seafloor.[110]

However, this concept has been problematic in its application to international space law.[111] For instance, the Moon Treaty was not ratified by a majority of countries—only two states with independent, space-faring programs signed it.[112] Thus, despite its good intentions, the treaty was largely ineffective. However, it seems clear that the existence and passage of the treaty shows an international belief that the resources beyond our sky should be regulated as common goods, rather than resources available for individual exploitation.

All in all, the four international treaties discussed above have a clear and common theme: space law should be characterized by collaboration among countries and shared benefit for all.[113] However, this theme conflicts directly with the most recent US law governing space.[114] This law, the SPACE Act of 2015, [115] amended Title 51 of the United States Code governing National and Commercial Space, to expand ownership in space well beyond the common heritage approach expounded by the Outer Space Treaty.[116] It states that

> [a] United States citizen engaged in commercial recovery of an asteroid resource or a space resource under this chapter shall be entitled to any asteroid resource or space resource obtained, including to possess, own, transport, use, and sell the asteroid resource or space resource obtained in accordance with applicable law, including the international obligations of the United States.[117]

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109. *Id.*

110. JANKOWITSCH, *supra* note 87, at 5–6.

111. Scott Ervin, *Law in a Vacuum: The Common Heritage Doctrine in Outer Space Law*, 7 B.C. INT'L & COMP. L. REV. 403, 404 (1984).

112. *See id.* at 424.

113. *See* G.A. Res. 2222 (XXI) (Dec. 19, 1966); G.A. Res. 2345 (XXII) (Dec. 19, 1967); G.A. Res. 2777 (XXVI) (Nov. 29, 1971); G.A. Res. 34/68 (Dec. 5, 1979).

114. *See* Spurring Private Aerospace Competitiveness and Entrepreneurship (SPACE) Act of 2015, 51 U.S.C. §§ 50101–51105 (2012).

115. *Id.*

116. Brian Fung, *The House Just Passed a Bill About Space Mining. The Future Is Here.*, WASH. POST (May 22, 2015), https://www.washingtonpost.com/news/the-switch/wp/2015/05/22/the-house-just-passed-a-bill-about-space-mining-the-future-is-here/ [https://perma.cc/3AEL-5CX4].

117. 51 U.S.C. § 51303 (2012).

Thus, the law essentially allows any American to own whatever he or she can grab in space and sell it once it is back on Earth.[118]

However, because these companies operate within and are governed by the United States, any resources they claim to own under the SPACE Act could be construed by the international community as belonging to the United States—thus directly breaching the principles set forth by the Outer Space Treaty and its progeny.[119] The fact that the SPACE Act allows Americans to mine and sell space resources "in accordance with applicable law, including the international obligations of the United States," renders itself meaningless, since the Outer Space Treaty prohibits anyone from owning space resources. Michael Listner, a lawyer at the consulting firm Space Law and Policy Solutions, explained this problem by saying, "It would be like you asking me for a piece of pie, and me saying, go over to my neighbor's house and take a piece of their pie, and then come back and thank me for it;" the United States cannot give out ownership rights to something that it cannot itself own.[120]

In drafting the SPACE Act, Congress was aware of this problem.[121] Before the Act passed, some members of the House Science Committee raised concerns that the new law would conflict with international treaties and, therefore, introduced an amendment calling for interagency studies on the legal issues of space resource property rights.[122] The amendment failed, however, because Representative Bill Posey of Florida convinced a majority that the reports would take years to complete and would fail to provide "any of the leadership or certainty that American companies need to move forward."[123]

In practice, however, the US Supreme Court could address and solve this conflict in a way that would allow the SPACE Act to maintain legitimacy. The Court has held that it is "a cardinal principle of statutory construction that a statute ought, upon the

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118. Sarah Fecht, *Senate Votes to Legalize Space Mining,* POPULAR SCI. (Nov. 11, 2015), http://www.popsci.com/congress-votes-to-legalize-asteroid-mining [https://perma.cc/5UM5-TV9M].

119. Nick Stockton, *Congress Says Yes to Space Mining, No to Rocket Regulation,* WIRED (Nov. 18, 2015, 10:00 AM), http://www.wired.com/2015/11/congress-says-yes-to-space-mining-no-to-rocket-regulations/ [https://perma.cc/TZ97-9VC4]. *Contra* Andrew Lintner, *Extraterrestrial Extraction: The International Implications of the Space Resource Exploration and Utilization Act of 2015,* 40 FLETCHER F. WORLD AFF. 139 (2016)

120. Fecht, *supra* note 118.

121. Jeff Foust, *Congress Launches Commercial Space Legislation,* SPACE REV. (May 26, 2015), http://www.thespacereview.com/article/2759/1 [https://perma.cc/4FXV-RA7J].

122. *Id.*

123. *Id.*

whole, to be so construed that, if it can be prevented, no clause, sentence, or word shall be superfluous, void, or insignificant."[124] This canon of statutory interpretation, which calls for the avoidance of as much "surplusage" as possible, holds that "it is appropriate to tolerate a degree of surplusage rather than adopt a textually dubious construction that threatens to render the entire provision a nullity."[125] Just as it construed the Affordable Care Act in a way to maintain the law's intent,[126] the Supreme Court here could read the SPACE Act's clause requiring adherence to existing law to specifically exclude the Outer Space Treaty.

Looking at the laws and treaties governing outer space, it seems that the international community favors a governing regime that prefers a collective ownership and shared benefits legal structure for outer space, rather than a system that allows for the spoils of space to go to the countries advanced enough to grab them first.[127] However, since this principle is almost entirely ignored by the SPACE Act of 2015, as well as by the existence of a privatized space mining industry, members of the international community are left to debate whether they should change international law, abandon it, or adhere to it and potentially allow it to stifle a burgeoning industry.[128]

III. THREE POTENTIAL "FUTURES" OF INTERNATIONAL REGULATION OF SPACE PROPERTY

Since the SPACE Act's allowance of space mining seems to violate the United States' international obligations, it seems that Congress intended either to violate international law or pass a useless law to appease would-be space prospectors.[129] Realistically, it is more likely the former, since this kind of hegemonic display of power is not new to America's history in international governance. For instance, the Bretton Woods system required members of the International Monetary Fund (IMF) to calculate their exchange rates in terms of the US dollar, which was still based on the gold standard.[130] This system

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124. LISA BRESSMAN ET AL., THE REGULATORY STATE 282 (Wolters Kluwer, 2d ed. 2013).

125. *Id.*

126. Nat'l Fed'n of Indep. Bus. v. Sebelius, 567 U.S. 2566, 2571 (2012).

127. *See generally* G.A. Res. 2222 (XXI) (Dec. 19, 1966); G.A. Res. 2345 (XXII) (Dec. 19, 1967); G.A. Res. 2777 (XXVI) (Nov. 29, 1971); G.A. Res. 34/68 (Dec. 5, 1979).

128. *See* Spurring Private Aerospace Competitiveness and Entrepreneurship (SPACE) Act of 2015, 51 U.S.C. §§ 50101–51105 (2012); Hays, *supra* note 18.

129. *See* 51 U.S.C. §§ 50101–51105.

130. Benjamin Cohen, *Bretton Woods System*, BENJAMIN J. COHEN, http://www.polsci.ucsb.edu/faculty/cohen/inpress/bretton.html [https://perma.cc/TFE4-PK4A] (last visited Feb. 25, 2017).

was a symbol of US hegemony because it was "dependent on the preferences and policies of its most powerful member, the United States."[131]

The treaties discussed above were produced in the Cold War era, mostly in response to the United States or the Soviet Union exercising their spheres of influence over the remaining countries.[132] But in today's world, where space actors are no longer tied directly to their national governments, and where the world's powers cannot as easily exercise pressure on other states, there are likely more ways to regulate outer space than have previously been utilized.[133]

In general, there are three potential solutions to the governance of property rights as related to space mining, each associated with an existing law or institution: hegemony, wherein one nation establishes dominance and exerts its power upon the rest of the community; an ad hoc regime, wherein the international community passes laws as issues arise; and enhanced international institutions, through which the international community creates a regime to govern a new legal issue in advance to aid in efficiency and clarity of the law.[134]

A. Hegemony and the Use of Unilateral Global Power

The first potential solution is to engage in a hegemony, where one or two powerful countries with the ability to establish "space dominance" do so by way of military and political power.[135] Several scholars believe that this is indeed the future, citing the colonization of the continents of Africa and the Americas (which were governed by European hegemons) and the domination of the sea (by the British and later American navy).[136]

As discussed, the SPACE Act provides an example of how this option could manifest itself. The problem with this path, however, is that "it seems implausible that space control could be accomplished without serious opposition."[137] And although space analysts imagine a need for military power in the space mining context,[138] an American hegemony would likely come in the form of a Rule of Capture,

131. *Id.*

132. MOLTZ, *supra* note 17, at 178–79.

133. *Id.* at 179.

134. *Id.*

135. *Id.* at 179–80.

136. *Id.* at 180.

137. *Id.* at 181.

138. *Id.* ("The United States cannot unilaterally protect all of its satellites, or prevent others from acquiring the means to threaten them.").

mandated not by military strength, but by the United States' position as the only state with laws authorizing the mining of mineral-rich asteroids.[139] By the time other states have the technology to compete, American corporations may have laid claim in one way or another to nearly all usable asteroids.[140]

Hegemony has many benefits, not the least of which being a near-complete lack of institutional cost. By simply ignoring international law, America would be able to do what benefits itself and likely face very little punishment.[141] Although the United States may suffer reputational consequences of such blatant disregard of the Outer Space Treaty, there are many who think that no amount of American disregard for international law will cause it to cease being the "indispensable" nation for the creation of international policy.[142]

Moreover, the SPACE Act also appears to sponsor an exercise of American hegemonic power because it requires the President to "promote the right of United States citizens to engage in commercial exploration for and commercial recovery of space resources free from harmful interference," without clarifying what does and does not constitute such interference.[143] This vagueness implies that private US companies could stake out several—if not all—useful resources within reach before any other states could even build the technology to compete, giving the United States a monopoly in space resources.[144]

Even if another country could gain access to necessary technology rapidly enough to compete with American companies in space (the Japanese, for example, used a probe to return asteroid samples to Earth in 2010),[145] the space mining industry would likely face the same issues that the oil industry experienced after decades of

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139. *See* Thomas E. Simmons, *The Unfortunate Provincialism of the Space Resources Act*, SPACE REV. (Jan. 25, 2016), http://www.thespacereview.com/article/2910/1 [https://perma.cc/L4GV-MVAS].

140. *See* Luc Olinga, *New US Space Mining Law to Spark Interplanetary Gold Rush*, PHYS.ORG (Dec. 8, 2015), http://phys.org/news/2015-12-space-law-interplanetary-gold.html [https://perma.cc/7FTZ-HEMF].

141. For a scathing review of the United States' general disregard for international law in the past, see Alfred S. McCoy, *You Must Follow International Law (Unless You're America)*, NATION (Feb. 24, 2015), https://www.thenation.com/article/you-must-follow-international-law-unless-youre-america/ [https://perma.cc/Y5FB-HNZD].

142. *See* Tamara C. Wittles, *American Hegemony: Myth and Reality* (Mar. 22, 2017), https://www.brookings.edu/articles/american-hegemony-myth-and-reality/ [https://perma.cc/GVY6-5R8G].

143. Spurring Private Aerospace Competitiveness and Entrepreneurship (SPACE) Act of 2015, 51 U.S.C. §§ 50101–51105, 51302 (2012).

144. *See* Fabio Tronchetti, *The Space Resource Exploration and Utilization Act: A Move Forward or a Step Back*, 34 SPACE POL'Y 6 (2015).

145. Andrew Rosenblum, *How to Mine an Asteroid*, POPULAR SCI. (Dec. 16, 2011), http://www.popsci.com/science/article/2011-11/how-mine-asteroid [https://perma.cc/54SM-7QVM].

the "rule of capture." Though a rule of capture led to an innovation race in the oil industry, with new technological developments being invented rapidly so that owners could get an efficiency edge on competitors, it also had the almost inevitable side effect of overconsumption and waste.[146] Early oil developers would burn off excess gas when drilling for oil, not realizing until years later that the gas burnt was actually usable and sellable natural gasoline.[147] It is not far-fetched to imagine that similar issues could arise with space mining—probes only have limited cargo space for minerals, and the refuse left behind could constitute potentially valuable and useful material.[148]

B. Ad Hoc Solutions

A second potential solution is the current system created by the extant international space law: a "piecemeal" solution made of ad hoc problem solving.[149] This form of "soft governance" relies upon the creation of new roles and expectations in the international community, which will pressure actors into behaving according to the ideal norms.[150] The mechanism put in place by the Space Data Association, for example, acts as a self-policing regime in which information about satellite locations and maneuvers is shared and participants are able to coordinate their satellites to prevent collision.[151] Similarly, the proposed International Code of Conduct for Outer Space Activities would create a kind of "neighborhood watch" system in which information is shared and a fear of blame and shame would prevent parties to the code from acting in a harmful or risky manner.[152] Systems like these have been and could continue to be successful for the future of space rights.[153]

The Outer Space Treaty provides an example of the type of governance that would come from applying ad hoc solutions to the rising tide of the space mining industry.[154] By creating a norm that the resources and bodies in space are beyond property rights—or, to use language from the Moon Treaty, part of the "common

146. FRED BOSSELMAN ET AL., ENERGY, ECONOMICS AND THE ENVIRONMENT (Foundation Press, 3d ed. 2010).

147. *Id.*

148. *Id.*

149. MOLTZ, *supra* note 17, at 182.

150. *Id.*

151. *Id.*

152. *Id.*

153. *Id.*

154. *Id.*

heritage"—these treaties would create norms that shame those who act unilaterally and against the "greater good" mentality.

Ad hoc approaches have been and are generally successful. They have the benefit of being less of an affront to international law than the exercise of power by a single military hegemon, while also being less institutionally costly and difficult than establishing new institutions and treaties to govern.[155] In essence, this approach is "flexible" because it can include "a variety of other actors [beyond national governments], who could perhaps manage and prevent conflicts more effectively through the use of market-based mechanisms or other informal rules."[156]

However, it might arguably be too late for such norms to be created. These types of piecemeal treaties typically fail to consider national power and, without clear legal rules and formal mechanisms to punish errant behavior, have little-to-no ability to impose sanctions.[157] This type of failure is already occurring, as the SPACE Act plans to abandon the norms of the Outer Space Treaty without any fear of the "blame" and "shame" that might arise from other countries.[158] This is why many experts advocate for more formal organizations and enforcement regimes when looking to govern the future of space.[159] As one legal scholar put it, "[T]he legal regime for commercial activities on the celestial bodies contained in the Outer Space Treaty is clearly inadequate to manage foreseeable activities within the next twenty years without further intergovernmental elaboration and agreement."[160]

C. Enhanced International Institutions

The third proposed solution is the development of enhanced international institutions.[161] Institutions of this type are characterized by a formal organization based on intergovernmental agreements, clear legal structure, joint funding, coordinated technology, and a limited self-interested body independent of the United Nations.[162] Though certainly the most difficult solution to implement—success relies on countries' willingness to compromise

155. *Id.*
156. *Id.*
157. *Id.* at 183.
158. *Id.* at 127.
159. *Id.* at 187.
160. *Id.*
161. *Id.* at 186.
162. *Id.*

their own unilateral advantages for the broader advantages of peaceful development in space[163]—this type of regime, once accepted, could be resoundingly successful.[164]

The most pertinent example of such a regime is the International Space Station (ISS) program. The space station's construction was the product of a partnership between several countries, including the United States, Japan, and Russia.[165] But rather than being an ad hoc norm-based system, the partnership governing and regulating the ISS is a formal organization structured by detailed intergovernmental agreements.[166] The ISS almost certainly would not have been built without the contributions of involved countries and their adherence to the clear rules set up by the ISS program, which involved a detailed legal organization and coordinated contributions by each country.[167] Although some may argue that the ISS is not a regime used for the regulation of commercial interests in space, similar formal regimes have been used to regulate other areas of interest.[168]

Most notably, the creation of the United Nations Convention on the Law of the Sea (UNCLOS) and the International Seabed Authority helped interested nations determine how property rights should adhere to commercial interests in another "common heritage": the ocean floor.[169] The UNCLOS was the brainchild of Malta's Ambassador in 1967, Arvid Pardo, who believed that the Cold War was threatening to pollute, poison, and lay waste to the mineral-rich seabed.[170] On November 1, 1967, he asked the United Nations to declare the deep seabed and its resources "the common heritage of mankind," believing that such language would ensure that superpowers would not dominate the seafloor and that developing

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163. *Id.*

164. *Id.*

165. *International Space Station*, NASA, https://www.nasa.gov/mission_pages/station/cooperation/index.html [https://perma.cc/3WNT-XFF6] (last visited Feb. 25, 2017).

166. MOLTZ, *supra* note 17, at 186.

167. *Id.*

168. *See generally Funds, Programmes, Specialized Agencies, and Others*, U.N., http://www.un.org/en/sections/about-un/funds-programmes-specialized-agencies-and-others/index.html [https://perma.cc/BSU3-EZXX] (last visited Mar. 6, 2016).

169. Zell, *supra* note 61, at 500–01.

170. Div. for Ocean Affairs and the Law of the Sea, *The United Nations Convention on the Sea (A Historical Perspective)*, U.N., http://www.un.org/depts/los/convention_agreements/convention_historical_perspective.htm [https://perma.cc/KT6T-RCBQ] (last visited Feb. 24, 2017).

nations such as Malta would be able to have an equal share of and right to the profits buried within the ocean's depths.[171]

Thus, Pardo's speech was the catalyst for "a global diplomatic effort to regulate and write rules for all ocean areas, all uses of the seas and all of its resources."[172] This effort, which lasted some fifteen years, culminated in the Third United Nations Conference on the Law of the Sea, in which the general assembly aimed to develop a comprehensive treaty for the oceans.[173] By 1982, the United Nations adopted "a constitution for the seas": the UNCLOS.[174] Though this treaty largely set forth boundaries for the sovereignty and control of coastal nations (introducing, for example, a twelve-mile boundary for "territorial waters"), it was based off of shared use of a common resource—namely, access to "innocent passage" throughout the world's waterways.[175]

However, UNCLOS's first true commitment to the "common heritage" of the seafloor came in 1994, when the United Nations adopted amendments to UNCLOS and added Section XI to the convention, naming the "seabed and ocean floor and subsoil" and the resources thereof the "common heritage of mankind," while also establishing the International Seabed Authority (ISA).[176] The ISA "is an autonomous international organization through which States Parties" to UNCLOS orchestrate their activities affecting the commonly owned seafloor, especially as they relate to the resources within that area.[177] Effectively, the ISA regulates exploration and mining in the deep sea to prevent disturbance to the oceanic ecosystem,[178] while maintaining that all economic benefits derived from the seafloor resources be "for the benefit of mankind as a whole, irrespective of the geographical location of States," or be made to

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171. Zell, *supra* note 61, at 496; Div. for Ocean Affairs and the Law of the Sea, *supra* note 170.

172. Div. for Ocean Affairs and the Law of the Sea, *supra* note 170.

173. *See id.*

174. *Id.*

175. *See generally* G.A. Res. 2749 (XXV), ¶ 5 (Dec. 17, 1970) (declaring that the seabed and ocean floor "shall be open to use exclusively for peaceful purposes by all States, whether coastal or land-locked, without discrimination").

176. Zell, *supra* note 61, at 497; Agreement Relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea, Preamble, *opened for signature* July 28, 1994, http://www.un.org/Depts/los/convention_agreements/texts/unclos/closindxAgree.htm [https://perma.cc/F77E-K7PF].

177. Marta Chantal Ribeiro, *What Is the Area and the International Seabed Authority?*, INSTITUT OCÉANOGRAPHIQUE 2 (May 2013), http://www.institut-ocean.org/images/articles/documents/1367593542.pdf [https://perma.cc/B6X7-LBLT].

178. *Id.*

benefit all countries by way of "equitable sharing of financial and other economic benefits."[179]

Under the convention, states or companies need not acquire approval from the ISA before searching for resources, but so-called "prospecting" activities and other types of initial investment do not give those parties rights to any resources they may find.[180] Once resources are discovered, states or entities must acquire ISA approval to exploit them.[181] This approval is contingent upon an application, which requires signing a contract, paying a "substantial" fee, and creating an appropriate plan to limit damage to surrounding ecosystems.[182]

This solution balances the intentions of industrialized nations—who generally favor a "first in time, first in right" view of ownership because it promotes and rewards private investment—with those of developing nations, who argue that a rule of capture set-up would punish poorer countries that lack technology.[183] In fact, one legal scholar, Jeremy Zell, in 2006 suggested the creation of a new space agency based upon the ISA, which he called the Space Resource Authority (SRA).[184]

The SRA, according to Zell, would consist of an administrative body, including a "Council" that would act similarly to the ISA's Council, with duties of creating an approval and regulatory regime for the exploration and exploitation of outer space.[185] Unlike the ISA's Council, he suggested that the developing world should be able to elect members to the Council, but not be able to reserve seats—a change made to accommodate the common criticism of the Moon Treaty that the equitable sharing of power was too harshly executed against industrialized countries.[186]

Once the Council had been staffed, agencies seeking to mine asteroid resources would sign exploration and exploitation agreements, as they do for the ISA.[187] Once approved by the SRA, the agency could prospect for free (as in seabed exploration), but, as with the ISA, the act of prospecting would create no proprietary rights over

179. United Nations Convention on the Law of the Sea, art. 140, ¶ 1, *opened for signature* Dec. 10, 1982, http://www.un.org/depts/los/convention_agreements/texts/unclos/unclos_e.pdf [https://perma.cc/XJ7V-2KBX].

180. Zell, *supra* note 61, at 502.

181. *Id.* at 502–03.

182. *Id.* at 503.

183. *See id.* at 506–07.

184. *See id.* at 509.

185. *Id.*

186. *Id.*

187. *Id.* at 510.

discovered materials.[188] In order to receive rights to discovered materials, the agency would have to pay a fee for a permit to the goods and a separate fee for the right to exploit.[189]

The payment of fees, under Zell's plan, would not end there. Exploitation agencies would also have to pay a "production royalty" to the SRA, which could be based on any variety of rates, including "a percentage of the mine's gross proceeds, net proceeds, overall value of the minable materials, or some other determination of the mine's value," as long as it was available to help pay for the use of property that, according to Zell, belongs to all nations.[190] These royalty fees would act as an investment in developing nations' infrastructures, aiding those countries incapable of engaging in asteroid mining.[191] This, he says, would help prevent the issue of "direct equity sharing," which was the cause of the Moon Agreement's ultimate failure.[192]

However, this reliance upon the ISA as an example for a plausible international solution has one problem: the United States is not a signatory and has not ratified the amendments adopting the agency.[193] This decision came in spite of six four-star military officers' recommendations for signing the treaty, because many believed that the royalties required by the pact were too stringent.[194] Congress's opposition, moreover, was not limited to the ISA's application to the sea: former Defense Secretary Donald Rumsfeld, who testified before Congress, said that the "wealth distribution" scheme set up by the amendments was a "novel principle that has . . . no clear limits" that "could become a precedent for the resources of outer space."[195] Thus, it seems evident that even in 2012, American policy makers were opposed to the idea of wealth distribution as it related not only to the sea floor, but also to outer space.

Now, several years later, that is undoubtedly true. With Congress's adoption of the SPACE Act, America has made it evident to the international community that it believes a "first come, first served" system is the preferred method for governing property in outer space.[196] In fact, the current Congress is so dedicated to the idea of an

188. *Id.*

189. *Id.*

190. *Id.* at 510–11.

191. *Id.* at 512–13.

192. *Id.* at 513.

193. *See, e.g.*, Kristina Wong, *Rumsfeld Still Opposes Law of Sea Treaty*, WASH. TIMES (June 14, 2012), http://www.washingtontimes.com/news/2012/jun/14/rumsfeld-hits-law-of-sea-treaty/?page=all_[https://perma.cc/D7VX-W9LH].

194. *Id.*

195. *Id.*

196. Stockton, *supra* note 119.

unregulated rule-of-capture type of governance that it specifically wrote a provision in the SPACE Act allowing for the industry to act with little-to-no regulatory oversight for eight years.[197]

Even without America's institutional reluctance to accept a system like the ISA, such a regime would not be an efficient way to manage asteroid mining, given the way asteroids are mined.[198] Under Zell's SRA, mining agencies would be required to reserve half the value of minable materials to the SRA's Enterprise, another body of the proposed agency.[199] This Enterprise would then be allowed to sell easements or ownership interest in both the mined materials and the leftover "surface" of the asteroid to other countries.[200] The problem, however, is that many asteroid mining processes either destroy or leave useless the remaining asteroid.[201] Though it is possible to purchase rights to half the water mined from the asteroids, any easement sold for the "surface" of the asteroid would be useless.[202] As a result, companies would be forced to forfeit rights to an agency that may not even be able to adequately sell those rights.

IV. A REGULATED RULE OF CAPTURE: EASEMENTS AND A FREER MARKET

The proper agency solution to create accord between the SPACE Act and the international treaties governing outer space should encourage the high-risk, high-capital nature of the asteroid mining industry while also preventing waste and protecting the interests of less developed nations in the "common heritage" beyond Earth's atmosphere.

Therefore, the best solution for regulating the future of space mining as an industry lies in the creation of a new international governing body—an institution capable of managing and collecting data on the resources being mined in order to prevent waste and harm, while still allowing for the free market principles which will encourage new and necessary innovation. This agency would not only

197. *Id.* (noting that, although "FAA still issues licenses for all US spacecraft launches and reentries," there is minimal regulation on the space mining industry imagined by the SPACE Act).

198. *See* Rosenblum, *supra* note 145.

199. Zell, *supra* note 61, at 510–11.

200. *Id.* at 511.

201. *See Harvesting Water from Asteroids*, PLANETARY RESOURCES, http://www.planetaryresources.com/asteroids/#harvesting-water [https://perma.cc/D8EX-T2MC] (last visited Feb. 24, 2017) (showing how the proposed way to harvest water from the asteroids is by liquefying all water within the asteroid, then ejecting the water-less rock afterwards).

202. *See id.*

solve the issue of conflict between domestic American law and international treaty, but also solve the clear need for regulation over commercial space activity.[203] This agency should look much like the ISA, providing a system for cataloging and managing all missions to exploit asteroid resources without stifling the potential gains that would create incentive for companies to invest in the work in the first place. It could be adopted at the UN Committee on the Peaceful Uses of Outer Space's annual meeting, held each summer.[204]

This agency should, like the ISA, require that all companies interested in mining asteroids register their intent and plan with the authority and provide evidence that they will not create waste or environmental destruction. Because asteroid mining, at least as it stands now, is in such a place that companies must spend months or years surveying asteroids for potential resources, the new agency should allow for "surveying licenses" and "exploitation licenses" so that companies could get their pick of accessible asteroids without having to commit to any one rock. Then, to prevent current industrialized nations' companies from laying claim to all mineable resources, thereby creating an even more pronounced rule of capture issue, the new agency could allow for companies with exploitation licenses to have rights to the resources for a set amount of time, after which the asteroid or celestial body again reverts to international, common heritage property.

Moreover, the agency should act as a judicial body that governs improper use of space property. Just as liability can be created from misuse, waste, or destruction on Earth, the new agency should develop a body of rules for managing the "environment" beyond our atmosphere. But rather than collecting damages payments from each liable nation *post hoc* (a tactic that has proven ineffective in international law),[205] the agency should require a fee for exploitation licenses, which, while entitling the purchaser to what could effectively be described as an easement in space, would also finance a liability fund out of which any necessary damages may be paid.

There are, of course, issues with the creation of a new agency to regulate space mining, not the least of which being the potential for

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203. *See* Fecht, *supra* note 8 (calling the SPACE Act "a short-term bill" that "might not be a sufficient step to fill in the gap resulting from a near-absolute absence of a national regulatory framework governing private mining activities on asteroids").

204. Stockton, *supra* note 119.

205. The Space Liability Convention, for example, has only been invoked once to respond to damages caused by a Soviet satellite malfunction, and led to a protracted process resulting in insufficient payouts. Joshua B. Horton et al., *Liability for Solar Geoengineering: Historical Precedents, Contemporary Innovations, and Governance Possibilities*, 22 N.Y.U. ENVTL. L.J. 225, 247–48 (2015).

disagreement. The United States, for example, has refused to ratify UNCLOS, despite ample reason for doing so.[206] A flaw with international law is that the largest powers are unlikely to cede power that would limit their own sovereignty and potential hegemony. As the Attorney General under President Reagan said, explaining the United States' decision not to ratify UNCLOS, "it was out of step with the concepts of economic liberty and free enterprise that Ronald Reagan was to inspire throughout the world."[207]

However, despite the ideological objections to international agreement, cooperation comes with many benefits. Not only would adherence to the space agency solve the conflict between the SPACE Act and the Outer Space Treaty, it would also allow for clarity of what is and is not allowed in space. This is highly valued by members of the federal government, just as the US military supported the Treaty of the Sea because it established "clear rights, duties, and jurisdictions of maritime states."[208]

Moreover, hegemonic deference to the agency will prevent those holding out from being essentially written out of power. Should all other interested states give power to the agency, any powers that hold out could potentially be harmed by those parties to the agency that wish to limit their own competition. This has occurred with the UNCLOS: China, a party to the treaty, rejects US interpretations of the treaty's freedom of navigation provisions and continues to control nearly the entire South China Sea.[209] But since the United States is not a party to UNCLOS, it cannot bring complaints about China's behavior to international dispute resolution bodies.[210] Especially where the United States and its companies have so much to gain from outer space expansion, such an inability to protect its interests could mean millions of dollars lost for American interests.

But the most important benefit of the proposed space agency is that it will allow for a cohesive space property policy. Without repealing the Outer Space Treaty, the only way that American space

206. Iosif Sorokin, *The UN Convention on the Law of the Sea: Why the U.S. Hasn't Ratified It and Where It Stands Today*, BERKELEY J. INT'L L. BLOG (Mar. 30, 2016), http://berkeleytravaux.com/un-convention-law-sea-u-s-hasnt-ratified-stands-today/ [https://perma.cc/AY3R-NT55].

207. UNITED NATIONS LAW OF THE SEA TREATY INFO. CTR., http://www.unlawoftheseatreaty.org/ [https://perma.cc/2596-34VK] (last visited Apr. 9, 2017).

208. Stewart M. Patrick, *(Almost) Everyone Agrees: The U.S. Should Ratify the Law of the Sea Treaty*, ATLANTIC (June 10, 2012), http://www.theatlantic.com /international/archive/2012/06/-almost-everyone-agrees-the-us-should-ratify-the-law-of-the-sea-treaty/258301/ [https://perma.cc/PH4C-7QBG].

209. *Id.*

210. *Id.*

companies can, as mandated by the SPACE Act, behave "in accordance with international law" is not to engage in any kind of ownership of celestial bodies. However, by allowing companies with the capability to go to space to, indeed, go and gather the resources capable of providing wealth and financial gain, the international community is encouraging the development in technology that could lead to scientific and technological advances not seen since the 1960s. Thus, allowing a UN agency to sell space easements, providing a way to allow individual ownership in space, the incentives are maintained and the interests of international law—peace, environmental maintenance, and scientific advancements—can be preserved.

V. CONCLUSION

Tackling the governance of space is a daunting task. However, the time has come for lawmakers to develop a system that both allows human ingenuity to flourish beyond our atmospheric borders and maintains the health and safety of the resources in the sky. As a result, the United States (along with the United Nations) should rely upon a new agency modeled after the ISA—a previously successful model—that will allow space pioneers to engage in their business while regulating the industry for the safety and well being of humanity.

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